## CLAIMS

1. A method for controlling the attitude of a satellite equipped with an attitude control system in a reference coordinate system (X, Y, Z) for positioning the satellite, and comprising at least three actuators called main actuators, two of which are control moment gyros each having a rotor driven so as to rotate about a fixed rotation axis with respect to a steerable gimbal that can be oriented about a gimbal axis perpendicular to the rotation axis of the corresponding rotor, and stationary with respect to the satellite, characterized in that:

    - the gimbal axes of the two control moment gyros are fixed so that these gimbal axes are parallel to each other and to the Z axis, the angular momentum vectors ($\vec{H}_1$, $\vec{H}_2$) of the control moment gyros therefore moving in the (X,Y) plane and making between them an angle ($\alpha$) which, by definition, corresponds to a skew $\varepsilon = 180 - \alpha$ between the angular momentum vectors ($\vec{H}_1$, $\vec{H}_2$) when $\alpha$ is different from 0° and 180°;

    - in addition to the two control moment gyros, at least a third main actuator is used as a complement, delivering torques in both senses in at least one direction not lying in the (X,Y) plane, so that this third main actuator is called the Z-axis main actuator;

    - a nonzero skew angle ($\varepsilon$) between the angular momentum vectors ($\vec{H}_1$, $\vec{H}_2$) of the control moment gyros is imparted, said skew angle ($\varepsilon$) preferably being chosen to be small enough not to create an excessively large internal angular momentum on board the satellite but large enough to ensure controllability of the attitude control system along the three axes (X, Y, Z) without necessarily having to modify the rotation speed of the rotor of at least one of the control moment gyros;

    - the kinematic and dynamic variables, which are necessary for controlling the attitude of the satellite, such as for example the attitude angles and

angular velocities of the satellite along the three axes, are estimated from measurements provided by sensors used on board the satellite;

     - setpoint variables, intended to allow objectives assigned to the satellite attitude control system to be achieved, such as for example the tilting and pointing along at least one of the three axes of the (X, Y, Z) coordinate system, are calculated; and

     - control commands are calculated, from differences between said estimated variables and said setpoint variables, and then sent to the main actuators, these control commands being intended to control the change in said differences over time, said control commands transmitted to the control moment gyros comprising at least commands intended to vary the orientation of their gimbal axes, such as for example gimbal angular position setpoints that have to be generated by a local position feedback control, or electric current setpoints, for currents that have to be injected into motors for orienting the gimbal axes.

2. The control method as claimed in claim 1, characterized in that, during an initialization phase of the attitude control system, the angle ($\alpha$) between the angular momentum vectors ($\bar{H}_1$, $\bar{H}_2$) of the two control moment gyros is brought to a value substantially different from 180°, using at least one secondary actuator on board the satellite, for the purpose of substantially and cumulatively modifying the angular momentum of said satellite in at least one direction in the (X,Y) plane and/or optionally the Z-axis main actuator in the case in which the latter is used to generate an angular momentum component in the (X,Y) plane.

3. The control method as claimed in claim 2, characterized in that at least one of the following members is used as secondary actuator: magnetic-torquers, jet actuators, torque actuators of any other

type, these preferably being selected from those of said aforementioned members necessarily used on board the satellite for carrying out operations other than the normal mode of operation of the satellite.

4. The attitude control method as claimed in either of claims 2 and 3, characterized in that at least one actuator is used to generate torques along one, two or three axes of the reference coordinate system, the effect of which together with the satellite attitude control system is, simultaneously or sequentially, to modify the angle ($\alpha$) between the angular momentum vectors ($\vec{H}_1$ and $\vec{H}_2$) of the control moment gyros so that said angle ($\alpha$) remains within a specified range, and/or in that, simultaneously, or sequentially, said Z-axis main actuator can also be desaturated, especially when said Z-axis main actuator comprises at least one reaction wheel whose angular momentum must remain, in terms of modulus, below a given limit.

5. The control method as claimed in any one of claims 1 to 4, characterized in that the total angular momentum of the two control moment gyros, resulting from the skew between the angular momentum vectors ($\vec{H}_1$, $\vec{H}_2$) of said control moment gyros, is oriented in a direction normal to the orbital plane of the satellite.

6. The control method as claimed in any one of claims 1 to 5, characterized in that the total angular momentum of the pair of control moment gyros, resulting from the skew between the angular momentum vectors ($\vec{H}_1$, $\vec{H}_2$) of the two control moment gyros is compensated for by the projection in the (X,Y) plane of the cumulative specific moment to this effect by said third, Z-axis main actuator.

7. The control method as claimed in any one of claims 1 to 6, characterized in that:

- a setpoint configuration for the pair of control
moment gyros, away from the singular configurations for
which the angle (α) is zero or equal to 180°, and
possibly a temporal Z-axis angular momentum profile
5   that has to be performed by the third, Z-axis main
actuator are determined from the initial and final
conditions of the satellite in terms of attitude
angles, angular velocity and time, in such a way that
the angular momentum exchange, over an imposed time,
10  between the satellite, the two control moment gyros
brought into said setpoint configuration and the Z-axis
third actuator, brings about the desired attitude
maneuver; and

- the orientation of the gimbal of each of the
15  control moment gyros is brought, simultaneously and
possibly independently, into its setpoint orientation
thanks to an angular position setpoint sent, in open
loop, into a local servocontrol for controlling the
angular position of the gimbals; and
20  - the Z-axis angular momentum profile is
generated, simultaneously and possibly independently,
using the third, Z-axis main actuator, advantageously
at least one reaction wheel, the rotation speed of
which will consequently be varied.
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8.  The control method as claimed in claim 7,
characterized in that, on the basis of differences
observed in the generation of a maneuver profile with
respect to a predefined setpoint profile, closed-loop
30  commands are added to the open-loop setpoints sent to
the main actuators so as to reduce said differences.